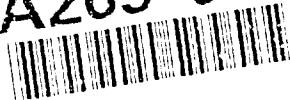


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**THE ARMY'S PIPELINE FOR  
TECHNOLOGICAL OFFICERS:  
IS IT BROKEN?**

BY

**COLONEL THOMAS A. LENOX**  
United States Army

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**The Army's Pipeline For Technological Officers:  
Is It Broken?**

**AN INDIVIDUAL STUDY PROJECT**

**by**

**Colonel Thomas A. Lenox  
United States Army**

**Colonel V. B. Corn  
Project Advisor**

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**U.S. Army War College  
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## ABSTRACT

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## **INTRODUCTION**

### **THE STRATEGIC IMPORTANCE OF AMERICAN TECHNOLOGICAL STRENGTH**

President George Bush frequently stressed the need to maintain technological leadership to ensure military readiness and strength. He pointed out that technology has historically been a comparative advantage for American forces, and that America has often relied on technology\* to overcome numerical disparities and to reduce the risk to lives.<sup>1</sup>

Secretary of Defense Dick Cheney stated: "To match potential adversaries' strength in numbers, the United States has always relied upon its technological edge, and this proven concept must be continued."<sup>2</sup> Chairman of the Joint Chiefs of Staff General Colin L. Powell has emphasized that advancement in technology is a national security obligation.<sup>3</sup>

The strategic importance of American technological strength is incontrovertible. There is overwhelming agreement that the future global situation will call for more technological knowledge. However, the preeminence of the United States as the world's leader in technology is being challenged by several other global powers. To meet this challenge, America must educate its citizens to be scientifically and technologically literate, and it must ensure that it has an adequate pool of citizens pursuing technical careers.<sup>4</sup> Further, Army officers must be prepared to assume leadership roles in this increasingly technological world.

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\*This paper uses the term "technology" in its most general sense -- to describe the body of knowledge related to the disciplines of science, mathematics, and/or engineering.

## **PURPOSE AND ORGANIZATION**

The question of vital importance to today's Army leadership is whether the Army has an adequate pool of officers to meet the Army's technological needs. Pre-commissioning programs are the primary means available to the Army to effect this pool of officers. The principal purpose of this paper is to address the following question of importance to the Army's leadership:

***DO THE ARMY'S PRE-COMMISSIONING PROGRAMS  
INSURE THAT IT HAS AN ADEQUATE POOL OF  
OFFICERS WHO ARE PROPERLY PREPARED TO MEET  
THE ARMY'S TECHNOLOGICAL NEEDS?***

Before exploring this question in detail, it is important that Army leaders understand the overall condition of our nation's technological education system. This is important for two basic reasons. First, pre-commissioning programs build upon the basic skills developed in America's primary and secondary schools. Pre-commissioning programs must have an ample source of young men and women who are qualified to participate in post-secondary technological programs. Second, pre-commissioning programs furnish only a small portion of the personnel who fulfill the Army's needs. Army leaders should understand the condition of the underlying system that educates the other personnel who support these needs.

**This paper will consist of two parts. The first part will investigate the overall status of technological education in the United States. The second and principal part will examine the Army's pre-commissioning programs to provide conclusions and recommendations concerning the central question posed and highlighted on the previous page.**



# **THE CONDITION OF CIVILIAN TECHNOLOGICAL EDUCATION**

## **GENERAL**

The scientific literacy of the American public is appalling. A National Science Foundation survey on scientific literacy showed that less than half of the adults questioned knew the Earth rotates around the Sun once a year. Asked if astrology was very scientific, moderately scientific, or not scientific at all, only 12 percent of this group gave the correct answer. The study concluded that 95 percent of Americans were scientifically illiterate.<sup>5</sup>

## **TECHNOLOGICAL PREPARATION IN ELEMENTARY AND HIGH SCHOOL**

The general technological illiteracy of the American public originates inside the schoolhouses of America. U.S. science and mathematics education at the primary and secondary levels is foundering. U.S. students were ranked as fair to poor in one survey comparing students' science and math achievement in 17 countries.<sup>6</sup> The results appear to get worse as students advance through elementary school. While U.S. fifth-graders ranked eighth among 15 responding nations, U.S. ninth-graders tied with those in Thailand and Singapore for fourteenth place in a field of 17 responding nations.<sup>7</sup>

Only six percent of high school seniors could answer the question: "If you had 10 coins, including one quarter, one dime, one nickel, and one penny; what would be the least amount of money you could have?"<sup>8</sup> Only five percent of high school graduates are prepared to take college-level science and mathematics courses.<sup>9</sup>

## **STATUS OF COLLEGE ENGINEERING PROGRAMS**

The poor preparation of high school students for advanced study of science and engineering is reflected in engineering enrollments in college engineering programs. Engineering enrollments have dropped 15 percent since 1983.<sup>10</sup> After initially enrolling in engineering programs, a significant portion of engineering undergraduates abandon their engineering programs. American universities are losing more and more engineering students between freshman and sophomore years; the attrition rate increased from 12 percent in 1975 to 27 percent in 1989.<sup>11</sup>

The pool of people from which to draw engineering and science talent in the 1990's will shift heavily to women and minorities. Unfortunately, statistics reveal a lack of participation from women and minorities in careers in these disciplines. In 1990, the women's share of engineering degrees was 15 percent for bachelor's degrees, 14 percent for master's degrees, and 9 percent for doctoral degrees.<sup>12</sup> In 1990, the analogous data for minority groups was 6 percent, 4 percent, and 2 percent.<sup>13</sup>

Although the U.S. still awards more degrees per capita than any other nation, the proportion of such degrees in engineering and science is less than the other two global economic powers, Japan and Germany. The proportion of undergraduate degrees in engineering and science was 19.9 percent in the U.S., 26.5 percent in Japan, and 33.8 percent in West Germany.<sup>14</sup>

Many of America's graduate degrees in engineering are conferred upon foreign students. The foreign share of M.S. degrees in engineering was 28% in 1990; at the doctoral level, the foreign share was to 49% in 1990.<sup>15</sup> Most engineering educators are not decrying the number of foreign students in

America's engineering graduate schools. These educators know that if it were not for first and second generation Asians, the engineering and science community in this country would be the worst among developed nations.<sup>16</sup> The problem is not too many foreign students, but too few Americans.

### **BASIC TECHNOLOGICAL EDUCATIONAL PROBLEMS**

Three very basic areas of America's educational system have emerged as urgently needing solutions. They include the faculty, the curricula, and instructional technology.<sup>17</sup> The length of this paper prohibits a complete analysis of these three areas; however, a few comments are provided below.

#### **Faculty**

As many as one-third of pre-college mathematics and science classes at all levels are taught by teachers not properly trained in those subjects.<sup>18</sup> In 1986, 66 percent of elementary school teachers had never taken a chemistry course, 30 percent had never taken a physics course, and 15 percent had never taken a biology course.<sup>19</sup> A third of the chemistry classes and half of the physics classes in high schools were taught by individuals who had studied a different field.<sup>20</sup>

In the university, most professors are properly trained in the subjects they teach; however, engineering professors are renowned for not knowing HOW to teach what they know. Besides poor teaching, engineering faculty are criticized for being unapproachable and not helping students in periods of academic difficulty. National Science Foundation studies have reported that most engineering programs are still operating as intellectual boot camps. To use the words of two NSF researchers:

All the schools and departments we studied had curriculum and assessment systems designed to "weed out the weak" and discourage students with insufficient interest or more aptitude in other fields. . . . As one engineering senior said, "You get people who would probably do well if they were given half a chance, but there's so much competition and not a heck of a lot of help." . . . The sheer difficulty of math and science courses is one thing, but when you factor in the large percentage of foreign professors, the picture gets worse.<sup>21</sup>

### Curricula

Although 90 percent of high school students take one year of biology, only 45 percent take one year of chemistry, and only 20 percent take one year of physics.<sup>22</sup> And what do students learn in these courses? According to one study: "Mostly they learn to sit and listen to lectures, read the text, do end-of-chapter exercises, and work alone. . . . They progressively spend less and less time actually performing experiments, participating in field trips, applying their knowledge, or working in groups."<sup>23</sup> The lack of opportunity to do "hands-on" scientific work seriously degrades the quality of instruction and learning. No wonder students are not motivated to pursue technological subjects in college.

### Instructional Methods

Experts believe that the computer could prove to be an invaluable tool for learning science and mathematics. However, there are serious questions about whether teachers can make effective use of computers. More than 20 percent of science and mathematics teachers have no training in computers.<sup>24</sup> While virtually all elementary and high schools have computers, only 8 to 15 percent of science classes and 19 to 23 percent of math classes use them in a given week.<sup>25</sup> Moreover, most log in a total of 15 minutes or less on the computer during a typical week.<sup>26</sup>

### CONCLUSIONS: THE SHAPE OF THE TECHNOLOGICAL PIPELINE

The overall condition of the technological pipeline is best illustrated in Figure 1.<sup>27</sup> It indicates the eventual educational choices of the approximately 4 million high school sophomores in 1977. Of these 4 million sophomores, 750 thousand expressed an interest in the natural sciences and engineering. Seven years later, only 206 thousand (or just 5% of the original number of sophomores) received a bachelor's degree in natural science or engineering.

## ENGINEERING PIPELINE

SOURCE: National Science Foundation

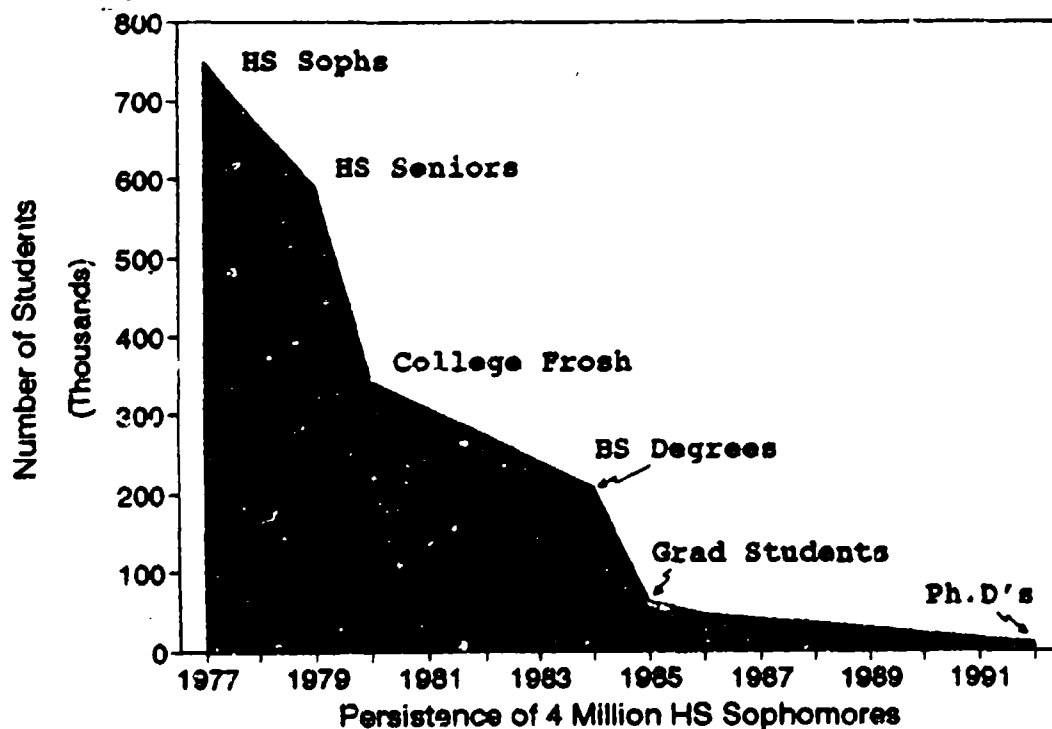


Figure 1: Engineering Pipeline

As stated by a senior program director at the National Science Foundation (NSF): "It is clear that from the flood of students who initially pour into the pipeline, only a few trickle out at the end."<sup>28</sup> Two foreboding conclusions can be drawn from this data and the other facts previously presented in this part of the paper:

1. Most Americans are not being properly educated to function in the everyday world of the next century.
2. Only a small segment of society is being prepared for careers in technical fields.

The evidence reveals there is an inadequate pool of citizens who are scientifically and technologically prepared to meet future global technological and economic challenges. In the somber words of the National Commission on Excellence In Education:

Our Nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world. . . . The educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people. . . . What was unimaginable a generation ago has begun to occur - others are matching and surpassing our educational attainments. . . . If an unfriendly foreign power had attempted to impose on America the mediocre educational performance that exists today, we might well have viewed it as an act of war. . . . We have, in effect, been committing an act of unthinking, unilateral educational disarmament.<sup>29</sup>

# **THE ARMY'S PROGRAM FOR PREPARING "HIGH TECHNOLOGY" OFFICERS**

## **GENERAL**

Two key points were made in the first part of this paper. First, America must maintain its technological leadership to ensure military readiness and strength. Second, America's educational systems have exhibited serious deficiencies in preparing its citizens for the technological world of today.

The sobering conclusion is that there is an inadequate pool of citizens who are scientifically and technologically prepared to meet future global technological challenges. As a result, it is incumbent on the Army to have a system to insure that it has an adequate entry pool of officers who are scientifically and technologically prepared to meet future leadership challenges. The remainder of this paper will explore this system.

## **GENERAL CONSIDERATIONS OF ARMY OFFICER ACQUISITION TRAINING**

Army Officer Acquisition Training consists of training and education programs leading to a commission in the United States Army. These programs must fulfill the need for junior officer entrants into the career force and for non-career junior officers in the force structure. Army Officer Acquisition Training programs produce officers for both the active forces and the Reserve Components. Army Officer Acquisition Training may be divided into the following three separate programs:<sup>20</sup>

1. The United States Military Academy (USMA) presents a long lead-time program that produces highly trained career officers.

2. The Reserve Officers' Training Corps (ROTC) is also a long lead-time program and provides the largest single input of officers to the active duty force, although many of these officers will leave active duty and join the Reserve Components. In this manner, ROTC provides officers to support the total force, both active and reserve.

3. Officer Candidate Schools (OCS) provide the short lead-time commissioning source necessary to respond to immediate surges in officer requirements, since the programs can be expanded or reduced in a relatively short time. Enlisted members can use this route to "rise from the ranks."

Table 1 shows the contribution of each of these three commissioning sources between 1979 and 1991.

Table 1: Active Duty Commissions by Source, 1979 to 1991.			
<u>YEAR</u>	<u>USMA</u>	<u>ROTC</u>	<u>OCS</u>
1991	980	2935	357
1990	978	4031	258
1989	1053	4749	184
1988	990	4082	536
1987	1069	3529	388
1986	1023	4669	750
1985	1067	4745	769
1984	965	5389	736
1983	882	4770	830
1982	885	3647	757
1981	952	3981	753
1980	903	4077	709
1979	902	4525	633



Due to reductions in officer end strength, OCS has declined as a source of commissioned officers. The OCS program is currently conducted as a fourteen week branch immaterial program at Fort Benning, Georgia. In 1991 and 1992, less than 10% of officer accessions came from Officer Candidate Schools.<sup>31</sup> Because of the small numbers of officers commissioned through OCS, this paper will address only USMA and ROTC in considering Army programs preparing technologically ready officers. It is to be emphasized that the only reason for this exclusion is the small number of officers commissioned through this source. However, some college students in highly specialized academic disciplines, such as engineering and physical sciences, cannot afford the time required to participate in ROTC.<sup>32</sup> The Army leadership should keep in mind that OCS can be utilized to attract well-qualified engineering and physical science students who desire to become Army officers after graduation from college.

The Reserve Officers' Training Corps and the United States Military Academy commission over 90% of the Army's commissioned officers and most of its "high technology" officers. *In this study, "high technology officer" will refer to officers whose undergraduate degree falls into the physical science or engineer categories.* Examples of physical science degrees include chemistry, biology, computer science, and geography. Examples of engineering degrees include civil, mechanical, electrical, and environmental engineering. These categories will be defined more precisely in subsequent portions of this study.

Historically, a sizable number of USMA's graduates have been classified as "high technology" officers. Since this commissioning source is considered by many Army leaders as the "high technology" foundation of the Army, it will be investigated first.

## **USMA: HIGH TECH FOUNDATION OF OFFICER CORPS?**

### **A Look Back: One Academy - One Program**

Established by Congress in 1802, the United States Military Academy was America's first institution of higher education in engineering and, after the Ecole Polytechnique, one of the first in the world.<sup>33</sup> In the nineteenth century, growing transportation needs associated with westward expansion brought a great demand for engineering skills. The United States Military Academy was one of the few schools that could help meet the demand. Engineering remained a prestigious career choice of cadets throughout the nineteenth century. From 1891 through 1900, every top Academy graduate chose the Corps of Engineers as his branch of service, and in six of the ten years, the top five men in the class selected the Corps of Engineers.<sup>34</sup>

A set "core" curriculum existed for all cadets up through 1960; the only option was the choice of a foreign language (French or Spanish). This curriculum was based heavily on basic science and engineering courses. For example, of the 44 core courses taken by the Class of 1957, 26 were math, science, and engineering.<sup>35</sup> However, the 1960's began the evolution of the USMA curriculum away from the fixed core curriculum that had existed for more than a century and a half. Of direct importance to this study, this evolution was to effect the "technology" base of the curriculum.

### **Electives at West Point**

Clearly, the most significant changes in the curriculum at USMA during this century have been associated with the introduction of elective courses. In 1960, Superintendent (LTG) Gar Davidson, with the approval of Army Chief of

Staff (GEN) L. L. Lemnitzer, established a formal elective program as part of the USMA curriculum.<sup>36</sup> Cadets were permitted to select two courses from a choice of 36 possible electives.<sup>37</sup> This had little effect on the overall technological base. All cadets still took a minimum of 26 math, science, and engineering (MSE) courses, comprising more than half of their total course load.

The percentage of MSE courses taken by all cadets reached a twentieth century low by 1982. In the aftermath of the cheating scandal of 1976, both the Borman Commission<sup>38</sup> and the West Point Study Group<sup>39</sup> recommended a reduction of the overall academic load and the number of core courses. In addition, each cadet was required to select a specific area of concentration (not quite a full disciplinary "major").<sup>40</sup> Their recommendations were fully in place for the Class of 1982. The curriculum was reduced from 48 to 40 courses. A cadet graduating in 1982 could take as few as 13 (or 32.5%) of these 40 courses in the MSE area.<sup>41</sup> However, it should also be noted that about half of all cadets elected to concentrate in a MSE discipline, taking all ten of their elective courses in the MSE area.<sup>42</sup> The programs taken by these cadets would be 58% MSE, the same percentage of MSE courses taken by cadets from twenty years earlier. Even though it might be questionable to classify ALL USMA graduates as "high technology" officers, clearly this label was valid for a great number of cadets.

### Academic Majors at West Point

In 1981, the Chief of Staff of the Army, General E. C. Meyer, indicated to the Superintendent that the time might be right to move to "majors." The majors program was in place for the Class of 1985. General Meyer recognized both the need for the Academy to produce officers with a sound foundation in

engineering, humanities, and the social sciences, as well as the realities of American higher education that demanded study in depth. These idealistic motivations were supplemented with some very practical reasons:

West Point graduates were finding it difficult to move into quality graduate programs in technical areas without considerable make-up work. In addition, the nation's principal engineering accreditation body indicated that, unless the Military Academy moved to "majors" in engineering, it would no longer permit West Point graduates to sit for the professional engineering examination.<sup>43</sup>

It was also alleged that USMA's chief recruiting rivals, the Naval and Air Force Academies, were using USMA's lack of majors and engineering accreditation to lure top high school student-athlete-leaders away from West Point.<sup>44</sup>

Even though the majors program was optional, all cadets were required to declare at least a field of study (a concentration of at least ten related electives). All cadets were required to complete a total of 44 courses, an increase of four courses over the previous curriculum. Two of these four additional courses were MSE, the other two free electives. Even though cadets majoring in a humanities and public affairs (HPA) field were only taking about 34% of their courses in technological disciplines, the minimum number of MSE courses taken by all cadets was increased to 15. At the other extreme, cadets graduating with a major in an accredited MSE field were completing technological programs comparable to the finest undergraduate engineering colleges in the nation. Their completion of 27 MSE courses certainly verified their classification as "high technology" officers.

### The Current USMA Program

With the Class of 1993, the number of academic courses required for graduation has been reduced from 44 to 40.<sup>46</sup> The four courses eliminated from the new baseline requirement include three electives (from 12 to nine) and one HPA (Humanities and Public Affairs) core course. Hence, the minimum number of MSE courses taken by all graduates has remained at 15.

Even though this minimum number of MSE has stayed constant, the nature of these courses has changed. In the previous academic program, all cadets not pursuing an engineering discipline as a major or field of study were required to take five "physical engineering" courses as part of their 15 required MSE courses. These five "physical engineering" courses were engineering mechanics, thermo-fluid mechanics, basic electrical systems, engineering decision methods, and engineering design (civil, mechanical, or electrical).<sup>46</sup> This standard "physical engineering" sequence has been replaced by several different engineering science and engineering design sequences. These sequences are shown in Table 2.<sup>47</sup> Today's non-engineering cadet can select any one of these sequences. Noteworthy is that two of these seven engineering core sequences (Systems and Computer Science) are not traditional "physical engineering" disciplines. For cadets not choosing a MSE field as a major or field of study, the technological content of their program has changed qualitatively rather than quantitatively.

<b>Table 2: USMA Core Engineering Sequences.</b>	
<b>1. CIVIL ENGINEERING:</b>	Statics and Dynamics, Thermo-Dynamics, Mechanics of Materials, Structural Analysis, and Design of Steel Structures.
<b>2. ELECTRICAL ENGINEERING:</b>	Introduction to Elect Engr 1, Introduction to Elect Engr 2, Digital Computer Logic, Electronic Design, and Electrical Systems.
<b>3. ENVIRONMENTAL ENGINEERING</b>	Hydrology, Statics and Dynamics, Environmental Systems Analysis, Environmental Systems Design, and Engineering Economy.
<b>4. MECHANICAL ENGINEERING</b>	Statics and Dynamics, Thermo-Dynamics, Mechanics of Materials, Introduction to Mechanical Design, and Mechanical Design.
<b>5. SYSTEMS ENGINEERING</b>	Deterministic Models, Probabilistic Models, Engineering Economy, Introduction to Systems Design, and Systems Design.
<b>6. NUCLEAR ENGINEERING</b>	Statics and Dynamics, Thermo-Dynamics, Modern Physics, Nuclear Reactor Theory, Nuclear Reactor Design, and Nuclear Systems Design.
<b>7. COMPUTER ENGINEERING</b>	Fundamentals of Computer Science, Informations Systems, Database Systems, Information Systems Design I, and Information Systems Design II.

Cadets who choose an optional major in a MSE field must still complete 27 MSE courses. With the elimination of one HPA core course, their total course load has been reduced from 44 to 43 courses. The reduction of the graduation requirement has had virtually no effect on the technological content of the academic program of these cadets.

### **Are Academy Graduates Physical Scientists and Engineers?**

What has the net effect been of over 30 years of curriculum changes at the United States Military Academy? Table 3 gives an intriguing macro-view of these changes.

**Table 3: Evolution of the USMA Curriculum,  
Class of 1961 to 1993.**

<b>SUBJECT AREA</b>	<b>TYPE</b>	<b>Number of Courses By USMA Class</b>					
		1961	1971	1982	1985	1993 (FOS)	1993 (MAJOR)
Mathematics	MSE	6	6	4	4	4	4
Mechanics	MSE	4	2	2	2	0	0
Engineering	MSE	4	2	2	2	2	2
Chemistry	MSE	2	2	1	2	2	2
Physics	MSE	2	3	2	2	2	2
Elect Engr	MSE	4	2	1	1	0	0
Engr Science	MSE					3	3
Environ/Geog	MSE	2	2	0	1	1	1
Engr Fund/Comput	MSE	2	2	1	1	1	1
Social Sciences	HPA	4	4	4	3	3	3
Law	HPA	2	2	1	2	1	1
Psychology	HPA	2	2	2	2	2	2
Foreign Lang	HPA	4	4	3	2	2	2
English	HPA	4	4	3	3	3	3
Philosophy	HPA			1	1	1	1
History	HPA	4	4	3	4	4	4
Electives (HPA or MSE)		2	7	10	12	9	12
<b>TOTAL COURSES</b>		<b>48</b>	<b>48</b>	<b>40</b>	<b>44</b>	<b>40</b>	<b>43</b>
<hr/>							
<b>TOTAL MSE CORE COURSES</b>		<b>26</b>	<b>21</b>	<b>13</b>	<b>15</b>	<b>15</b>	<b>15</b>
<b>TOTAL HPA CORE COURSES</b>		<b>20</b>	<b>20</b>	<b>17</b>	<b>17</b>	<b>16</b>	<b>16</b>
<b>TOTAL ELECTIVE COURSES</b>		<b>2</b>	<b>7</b>	<b>10</b>	<b>12</b>	<b>9</b>	<b>12</b>

Certain facts are irrefutable:

1. The percentage of the core curriculum devoted to HPA courses has remained remarkably consistent over the last thirty years.

2. The percentage of the core curriculum devoted to MSE courses has been reduced by over 40% (26 courses to 15 courses) in the last thirty years.

3. Over the last thirty years, cadets who select a major or a field of study in a MSE field have taken approximately the same number of MSE courses.

4. *The net effect of the curriculum changes over the last thirty years has been a sharp reduction in the number of MSE courses taken by cadets who select an HPA major or field of study.*

In the words of Dean (BG) Roy K. Flint:

Many graduates will recognize that the introduction of electives and, more recently, majors programs has resulted in a substantial reduction in the number of courses in the mathematics, science, and engineering component of the core curriculum compared to the curriculum of the 1960's. Cadets in recent classes have taken four math courses (vs six), two physics (vs three), two mechanics (vs four), one electrical engineering (vs four), and two engineering design courses (vs four).<sup>48</sup>

On the basis of this analysis, a key question must be answered. Are ALL graduates of the United States Military Academy "high technology" officers? The historical data suggests an unequivocal NEGATIVE answer to this question. Graduates with a major or a field of study in a MSE field clearly qualify as either engineers or physical scientists (depending on their specific discipline). However, classifying USMA graduates specializing in an HPA field as "high technology" officers is exaggerated and dubious.

About how many "high technology" officers CAN we expect from each USMA graduating class? An analysis was made of the majors and fields of



study selected by cadets during the end of their second year at the United States Military Academy<sup>49</sup>. This data is compiled in Table 4. Looking at this table, it appears that about 50% of each graduating class can be classified as "high technology" officers.

<b>Table 4: USMA Academic Discipline Choice of Second Year Cadets.</b>		
<b><u>Class</u></b>	<b><u>MSE%</u></b>	<b><u>HPA%</u></b>
<b>1991</b>	<b>52%</b>	<b>48%</b>
<b>1990</b>	<b>55%</b>	<b>45%</b>
<b>1989</b>	<b>45%</b>	<b>55%</b>
<b>1988</b>	<b>42%</b>	<b>58%</b>
<b>1987</b>	<b>46%</b>	<b>54%</b>
<b>1986</b>	<b>53%</b>	<b>47%</b>
<b>1985</b>	<b>55%</b>	<b>45%</b>

### **THE RESERVED OFFICERS' TRAINING CORPS AND THE ARMY OFFICER ACCESSION REQUIREMENT SYSTEM**

#### **ROTC: A Brief History**

The United States entered the Civil War with far too few leaders, and the majority of the federal officers were military amateurs who learned their trade on the job.<sup>50</sup> This fact was not lost on President Lincoln. In 1862 he signed the Land-Grant College Act which established programs for agricultural and industrial colleges in each state. The legislation specified that military tactics were to be included in the curriculum of these schools. This legislation was the

genesis of the Reserve Officers' Training Corps (ROTC). The Reserve Officers' Training Corps program was formalized in the National Defense Act of 1916. This legislation provided for federal control of reserve officer training and for the call up of these officers if there was an emergency.<sup>51</sup>

In 1964, with passage of Title 10, US Code, Section 2107, Congress initiated the ROTC scholarship program; a financial assistance program for specially selected members of the Reserve Officers' Training Corps. It provides for the appointment of cadets who meet certain requirements to be provided payment of expenses for tuition, fees, books, and laboratory expenses. Congress initially limited the Army to 5,500 scholarship cadets. Even though authorization was received in 1964, the Army's scholarship program did not become fully operational until 1970.<sup>52</sup> The maximum number of authorized scholarship accessions was increased to 6,500 in 1971 and to 12,000 in 1980.<sup>53</sup>

#### ROTC and the Accession Requirement System Before 1981

Table 5 shows the active duty accessions from the commissioning sources for selected years between 1964 and 1982.<sup>54</sup> It shows that ROTC provided the majority of the active duty line officers for the Army during this period, except during the peak years of the Vietnam War, when OCS provided the bulk of commissioned officers.

Table 5: Active Duty Officer Accessions by Source.				
<u>Year(s)</u>	<u>USMA</u>	<u>ROTC</u>	<u>OCS</u>	<u>OTHER</u>
1960	6.3%	78.1%	9.1%	6.6%
1968	2.2%	33.4%	59.4%	5.0%
1978-82	15.0%	68.7%	11.8%	4.5%

The Army can point with pride to a host of outstanding contributions from former ROTC cadets from this period. Most of the field grade and general officers (O-4 through O-8) now on active duty were commissioned from ROTC during these years. Nonetheless, a careful examination of the ROTC program before 1981 yields some startling revelations.

Thousands of ROTC scholarships were awarded annually, yet there was no guidance or control over academic programs. The absence of any control over the academic disciplines being pursued by scholarship students resulted in many ROTC graduates with academic majors of no direct application to a military career. A conclusion of the 1978 Officer Training and Education Review Group was: "Majoring in circus management is considered neither better nor worse than majoring in nuclear engineering."<sup>55</sup> In fact, fewer than one out of five officers commissioned from the ROTC in 1981 pursued undergraduate degrees in engineering or a physical science.<sup>56</sup> The Army certainly was not concerned about "high technology" officers; all college degrees were equally acceptable and satisfactory. The United States Military Academy was the Army's primary source of "high technology" officers during this entire period.

### **The 1981 Accession Plan: A System Based Upon Major**

The 1978 Officer Training and Education Review Group recommended that ROTC scholarship recipients be required to select a course of study that related to Army requirements.<sup>57</sup> In 1981, the Deputy Chief of Staff for Personnel (ODCSPER) directed a study of the optimal mix of academic disciplines (ADM) appropriate for the accession of active duty officers.<sup>58</sup> As a result of this study and the perceived requirement for hard-skill academic disciplines, DCSROTC (Deputy Chief of Staff, Reserve Officers' Training Corps) was directed by ODCSPER to obtain a variety of academic disciplines in newly commissioned officers. The goals established by the Department of the Army for the academic mix of undergraduate majors are shown in Table 6.<sup>59</sup>

Table 6: 1981 Academic Mix Goals.	
<u>Academic Discipline</u>	<u>Accession Goal</u>
Engineering	20%
Science	20%
Business	30%
Social Science	20%
Other	10%

These numbers were developed based upon a logical process of formulating an overall officer accession plan by specialty code, producing an additional specialty designation plan for each specialty, and developing the relationship between these specialty requirements and the five academic disciplines tabulated above. This methodical approach made it possible to quantify the desired distribution of officers by academic majors and to

associate this distribution with the initial specialty (commissioning branch) of each year's officer accessions.<sup>60</sup>

The Reserve Officers' Training Corps found it very difficult to meet the technical academic discipline mix directed by ODCSPER. ROTC's accession data during the first five years of the plan are shown in Table 7.<sup>61,62</sup>

Table 7: ROTC Accession Data 1981 - 1985		
<u>Year</u>	<u>Engineering</u>	<u>Science</u>
1981	9.6%	17.4%
1982	10.8%	15.2%
1983	11.0%	16.1%
1984	10.4%	17.5%
1985	11.9%	18.5%
GOAL	20.0%	20.0%

The ROTC community expressed concern that the academic discipline mix requirements were unreasonable. The fundamental basis for the academic mix goals was input from the officer specialty proponents. Many of these academic majors would not be utilized until the officer was working in an alternative specialty/functional area as a Captain or Major. ROTC also questioned the need to establish goals for social science and business majors. These majors brought no special technical skills to the military to address the Deputy Chief of Staff for Personnel's concern about the requirement for hard-skill academic disciplines. ROTC saw no reason why these two disciplines could not be lumped into the "OTHER" category.<sup>63</sup>

At any rate, a system was now in place for establishing a minimum goal for "high technology" officers to meet future Army needs. It established a clear-cut methodology for developing the Army's need for "high technology" officers in terms of five general categories. This need was correlated directly to the academic majors (or fields of study in the case of USMA graduates) pursued by officers as undergraduates. Even though the need for fine tuning was recognized, a workable and understandable system was in place.

### **The 1989 Accession Plan: A System Based Upon Credits**

The fine tuning of the system was to begin in the late 1980's. In January 1988, the Deputy Chief of Staff for Personnel was tasked by the Chief of Staff of the Army (CSA) to review/determine the academic discipline needs of the Army.<sup>64</sup> In response to this tasking, the ROTC Cadet Command convened a study group in May 1988 and started the development of the new academic discipline mix (ADM).

The Academic Discipline Mix Study Group (ADMSG-1989) recommended the reduction of the number of classification categories from five to four. This was a natural reaction to ROTC's skepticism about the need of establish goals for social science and business majors. The four new categories were established as shown in Table 8.<sup>65</sup>

**Table 8: Academic Discipline Definitions.**

<u>Academic Discipline</u>	<u>MSE Percent</u>
Engineer	51% and more
Physical Science	26% to 50%
Technical Base	11% to 25%
Generalist	Less than 11%

The most significant change in these categories was NOT the new names and the new number of categories. THE MOST NOTEWORTHY CHANGE IN THE NEW PLAN WAS THE MANNER IN WHICH THE FOUR ACADEMIC DISCIPLINE CATEGORIES WERE KEYED TO THE PROPORTION OF MATH, SCIENCE, AND ENGINEERING CREDIT HOURS IN THE TOTAL UNDERGRADUATE CURRICULUM. The 1981 plan was based upon academic major; this plan was based upon number of MSE credit hours as a proportion of the total curriculum. The ADMSG-1989 felt that by developing academic discipline groupings based upon the percentage of math, science, or engineering courses, the Army would be able to move away from traditional titles that may not have accurately identified the curriculum content.<sup>66</sup> Hypothetically, the name of the degree (or field of study) had nothing to do with the classification of a specific individual; the classification under the new system was based entirely upon the number of MSE credits in an individual program. An undergraduate majoring in history could be classified as an "engineer" if he/she took enough math, science, and engineering courses. Similarly, math and chemistry majors should be classified as "engineers" since they typically take more than 50% of their courses in math, science, or engineering.

The ADMSG-1989 needed to determine the new officer accession requirement for each of these four new categories. Theoretically, the factors considered in the development of the new Academic Discipline Classification System (ADCS) were to be the primary branch needs, additional specialty considerations, and Army Board requirements for the Army. In actuality, each branch proponent provided the requirements for each of the categories. They are shown in Table 9.

Table 9: 1989 Academic Discipline Statement of Need By Basic Branch.				
<u>BRANCH</u>	<u>GENERAL</u>	<u>TECH</u>	<u>PHY_SCI</u>	<u>ENGR</u>
IN	55%	15%	15%	15%
AR	56%	12%	16%	16%
FA	50%	15%	20%	15%
AD	30%	29%	18%	23%
AV	30%	30%	20%	20%
EN	10%	10%	20%	60%
SC	15%	30%	15%	40%
MP	45%	45%	5%	5%
MI	30%	30%	10%	30%
AG	40%	55%	5%	0%
FI	0%	100%	0%	0%
CM	10%	10%	70%	10%
TC	15%	45%	25%	15%
OD	10%	20%	45%	25%
QM	30%	30%	30%	10%
WEIGHTED AVG	35%	30%	15%	20%

Using these requirements as a base line, the ADMSG-1989 calculated a weighted average of the Table 9 data to serve as the accession goals that would support the Army. These accession goals are shown in Table 10.<sup>67</sup>



Table 10: 1989 Academic Mix Goals.	
<u>Academic Discipline</u>	<u>Accession Goal</u>
Engineer	20%
Physical Science	15%
Technical Base	30%
Generalist	35%

The impact upon ROTC was minimal. Even though the system was based upon counting the total number of math, science, and engineering credits taken by an individual, ROTC did not apply the system in this way. ROTC simply realigned their old academic discipline (major) codes with the four new categories.<sup>68</sup> Examples of this alignment are shown in Table 11.

Table 11: Example Alignments of Academic Degrees.		
<u>Degree</u>	<u>Academic Code</u>	<u>Category</u>
Language	ABX	Generalist
Area Studies	EBX	Generalist
International Relations	EKB	Generalist
Business	BXX	Technical Base
Chemistry	DDX	Physical Science
Mathematics	DHX	Physical Science
Civil Engineering	CCG	Engineer
System Engineering	CUX	Engineer

This realignment certainly seems logical based upon the names of the four categories. However, it violates the spirit of the new system for two reasons. First, ALL ROTC graduates with the same degree are put in the same

category even though they might have taken a different number of MSE credits. Remember, according to the new system, a foreign language major could be classified as an "engineer" if he/she had taken the appropriate number of MSE credits (admittedly, a very unlikely scenario). Second, and what is more important, there appears to be fundamental lack of compliance with the new system. In almost all civilian colleges, any student majoring in a math, basic science, or physical science discipline takes far more than 50% of their credits in math, science, and/or engineering courses. According to the new 1989 system, most physics, chemistry, biology, and mathematics majors should be classified as "engineers." However, the ROTC Cadet Command alignment of majors classifies these majors as "physical science" (see Table 11).

The impact upon the classification of USMA graduates was much greater. Using the previous (1981) system, USMA graduates were classified in one of the five categories based upon their field of study. As a result of the 1989 change in definition, ALL USMA accessions were classified as "physical science" or "engineering" lieutenants. For example, about 35% of the courses taken by a West Point English Literature major were in the math, science, and engineering disciplines; exceeding the 26% requirement for a classification as a "physical science" discipline. Similarly, ALL graduates who majored or concentrated in any MSE field were classified as "engineers" since much more than 50% of their curriculum was MSE. As a result, the academic discipline mix for the USMA graduating class of 1990 was 45% "physical science" and 55% "engineer."

The lack of consistency between ROTC and USMA is quite conspicuous. This inconsistency would result in such aberrations as classifying a chemistry

major from MIT as a "physical scientist," yet classifying a chemistry major from USMA as an "engineer." This could be the case EVEN THOUGH BOTH GRADUATES HAD THE SAME PERCENTAGE OF MSE COURSES! Two different ways of applying the same system caused such irregularities. The suitability of such an inconsistent system in insuring the flow of "high technology" officers into the Army was suspect.

The breakdown of actual officer accessions by branch are shown in Table 12.

Table 12: 1991 Actual Officer Accessions By Branch.				
<u>BRANCH</u>	<u>GENERAL</u>	<u>TECH</u>	<u>PHY_SCI</u>	<u>ENGR</u>
IN	36%	17%	25%	22%
AR	29%	25%	22%	24%
PA	35%	18%	25%	22%
AD	37%	17%	17%	29%
AV	39%	25%	14%	22%
EN	14%	12%	20%	53%
SC	30%	29%	16%	25%
MP	68%	16%	8%	8%
MI	66%	19%	7%	8%
AG	61%	26%	9%	4%
PI	14%	78%	7%	1%
CM	30%	18%	43%	9%
TC	49%	23%	14%	9%
OD	43%	24%	15%	18%
QM	48%	29%	15%	8%
WEIGHTED AVG	40%	22%	17%	21%

Of greater interest is how much these actual accessions differ from the Army's previous requirements as stated in Table 9. In other words, how does the supply of "high technology" officers compare to the demand. Table 13 was generated by comparing the supply data from Table 12 with the demand

data from Table 19. A positive number in Table 13 indicates an excess of accessions in that category; a negative number indicates a shortage.

Table 13: Comparison of Branch Requirements With Actual Accessions (negative = shortage, positive = excess).				
<u>BRANCH</u>	<u>GENERAL</u>	<u>TECH</u>	<u>PHY SCI</u>	<u>ENGR</u>
IN	-19%	2%	10%	7%
AR	-27%	13%	6%	8%
PA	-15%	3%	5%	7%
AD	7%	-12%	-1%	6%
AV	9%	-5%	-6%	2%
EN	4%	2%	0%	-7%
SC	15%	-1%	1%	-15%
MP	23%	-29%	3%	3%
MI	36%	-11%	-3%	-22%
AG	21%	-29%	4%	4%
PI	14%	-22%	7%	1%
CM	20%	8%	-27%	-1%
TC	34%	-17%	-11%	-6%
OD	33%	4%	-30%	-7%
QM	18%	-1%	-15%	-2%
WEIGHTED AVG	5%	-8%	2%	1%

From the data in Table 13, it appears that sufficient math, science, and engineering majors are available to meet the overall Army's needs (see the bottom line of this table). However, the reader must remember that there has been a redefinition in the terms "engineer" and "physical scientist." By changing the definition, the Army suddenly accessed about 400 more "engineers" and "physical scientists" from USMA each year since ALL USMA officers were categorized as "engineers" or "physical scientists." We have already discussed how classifying USMA graduates specializing in an HPA field as "high technology" officers is exaggerated and dubious.

In addition, Table 13 appears to show that there is a problem in the distribution of these academic categories to each branch.<sup>69</sup> This distribution

issue is also a function of the USMA accession process. By regulation, a minimum of 80% of the USMA class must be branched into the combat arms (CA) broadly defined as the Infantry, Armor, Field Artillery, Air Defense Artillery, Aviation, and Corps of Engineers.<sup>70</sup> No more than 20% may be branched into the remaining combat support (CS) and combat service support (CSS) branches. While 80% is the minimum fill for the combat arms, the actual fill is more like 90%.<sup>71</sup> Since all USMA officers are categorized as "engineers" or "physical scientists" and the vast majority of USMA graduates are commissioned in the combat arms, there is an apparent overfill of "high technology" officers in the combat arms branches (and underfill in CS and CSS).

In October 1990, the ROTC Cadet Command conducted an Accession Policy Review.<sup>72</sup> They found that almost all the combat arms accession requirements for "high technology" officers were being satisfied by USMA graduates. This finding was a matter of concern to the ROTC Cadet Command and to some branch proponents. The Cadet Command proposed the following:<sup>73</sup>

1. Classify USMA officers based on their degree title (e.g., History would be a "Generalist," Chemistry would be "Physical Scientist," and Civil Engineer would be "Engineer"). The percentage of the curriculum content that was MSE would be ignored.

2. Adjust the 80%/20% rule for USMA graduates. This would allow more USMA graduate into the combat support and combat service support branches, opening more combat arms opportunities for ROTC graduates.

USMA felt that this approach would create a greater and misleading shortage of "physical scientists" and "engineers." However, they

recommended an examination of the branch proponent rationale for determining the academic discipline mix (ADM) and of the 80%/20% rule.<sup>74</sup>

The Chief of Staff of the Army (CSA) was apprised of the Cadet Command Accession Policy Review. He directed that no change be made to accession policies for Fiscal Year 1991. However, he tasked DCSPER to provide recommendations for changes appropriate in Fiscal Year 1992.

### **The Academic Discipline Mix (ADM) Study of 1991**

In December 1990, the Office of the Deputy Chief of Staff for Personnel tasked TRADOC Headquarters to assume the lead in the study to determine the ADM requirements for lieutenants in the basic branches.<sup>75</sup> A study group was formed composed of representatives from ODCSPER, PERSCOM, TRADOC, USMA, Cadet Command, and the Army Research Institute. For the purpose of the study, *the Army's existing Academic Discipline Classification System (ADCS) categories were accepted* (review Table 8).

The 1991 Academic Discipline Mix Study Group (ADMSG-1991) tried to confirm or deny a perceived shortage of lieutenants in the "high technology" categories when viewed against the branch proponents' stated requirements. PERSCOM conducted an analysis, using the FY90 accession data, to get a better understanding of the nature of any imbalances in the academic discipline mix. A subset of their data has already been presented in this paper in Table 12. Using this data, the ADMSG-1991 came to similar conclusions as the ROTC Cadet Command Accession Policy Review. In their words:

On the basis of proponent input, initially we found that for FY90, there was not an overall shortage in the Physical Science or Engineer ADM. Rather, it appeared the problem was related to the distribution of lieutenants among the branches. *Later, however, based on a force structure assessment, we found there was a shortage of lieutenants in the Physical Science and Engineer ADM.(italics added)*<sup>76</sup>

The ADMSG-1991 proposed a new methodology for determining the Army's ADM requirements. Their approach was then modeled and fully developed by PERSCOM. A detailed description of the model and detailed results will not be discussed in this paper; it is included in the study group's report.<sup>77</sup> However, the overall approach will be summarized using the words of the study-group:

In essence, PERSCOM conducted a force structure assessment and prepared an OBJECTIVE STATEMENT OF NEED specifying the ADM needs by branch. It was prepared considering the future functional area requirements of each branch and considering the Army Education Requirements System (AERS), which identifies the need in the accession branches and nonaccession functional areas for officers with advanced civil schooling. Information was already available on the branch proponents' subjective preference in each of the ADM as provided to the FY90 accessions board. This PROPONENT STATEMENT OF NEED was combined with the OBJECTIVE STATEMENT OF NEED, giving equal weight to both, to create the ARMY STATEMENT OF NEED.<sup>78</sup>

The new Army Statement of Need by branch is shown in Table 14.

Table 14: 1991 Army Statement of Need By Branch.				
<u>BRANCH</u>	<u>GENERAL</u>	<u>TECH</u>	<u>PHY SCI</u>	<u>ENGR</u>
IN	50%	19%	12%	20%
AR	44%	17%	14%	27%
PA	40%	22%	16%	23%
AD	15%	26%	16%	44%
AV	18%	38%	15%	30%
EN	5%	14%	15%	67%
SC	8%	31%	15%	48%
MP	44%	36%	7%	14%
MI	32%	25%	9%	35%
AG	42%	44%	5%	10%
PI	0%	87%	3%	11%
CM	5%	15%	52%	28%
TC	8%	53%	17%	24%
OD	5%	35%	29%	31%
QM	16%	49%	19%	17%
WEIGHTED AVG	30%	25%	15%	30%

Of interest is how this new requirements statement compares with the previous requirements statement. Table 15 was generated by comparing the new 1991 Army Statement of Need (Table 14) with the 1989 ADM Statement of Need (Table 9). In Table 15, a positive number indicates that the new statement of need requirement is greater than the 1989 statement of need; a negative number indicates that the new need is less than the old need.



**Table 15: Comparison of 1991 and 1989 Statements  
of Need By Branch (positive means new need greater than old need).**

<u>BRANCH</u>	<u>GENERAL</u>	<u>TECH</u>	<u>PHY SCI</u>	<u>ENGR</u>
IN	-5%	4%	-3%	5%
AR	-12%	5%	-2%	11%
FA	-10%	7%	-4%	8%
AD	-15%	-3%	-2%	21%
AV	-12%	8%	-5%	10%
EN	-5%	4%	-5%	7%
SC	-7%	1%	0%	8%
MP	-1%	-9%	2%	9%
MI	2%	-5%	-1%	5%
AG	2%	-11%	0%	10%
FI	0%	-13%	3%	11%
CM	-5%	5%	3%	18%
TC	-7%	8%	-6%	9%
OD	-5%	15%	-16%	6%
QM	-14%	19%	-11%	7%
<b>WEIGHTED AVG</b>	<b>-5%</b>	<b>-5%</b>	<b>0%</b>	<b>10%</b>

Table 15 shows that there is an across the board increase in the Army need for "engineer" officers as compared to the old requirement. The overall bottom line need for "engineers" has increased substantially. While previously the Army's stated need for "engineers" was 20% of all accessions (see Table 10), the more refined analysis conducted in 1991 shows an overall need of 30% of all accessions. **THIS IS A 50% RATE OF INCREASE IN THE REQUIREMENT!** The other component of the "high technology" officer category, i.e., physical scientist, has retained the identical requirement of 15% of all officer accessions. Hence, the overall Army need for "high technology" officers is 45% of all officer accessions.

Of interest is how much the revised 1991 revised needs compare with the actual 1990 accessions as listed in Table 12. In other words, how does the supply of "high technology" officers compare to the demand. Table 16 was generated by comparing the supply data from Table 12 with the demand

data from Table 14. A positive number in Table 16 indicates an excess of accessions in that category; a negative number indicates a shortage.

Table 16: Comparison of 1991 Requirements With 1990 Accessions (negative = shortage, positive = excess).				
<u>BRANCH</u>	<u>GENERAL</u>	<u>TECH</u>	<u>PHY SCI</u>	<u>ENGR</u>
IN	-14%	-2%	13%	2%
AR	-15%	8%	8%	-3%
FA	-5%	-4%	9%	-1%
AD	22%	-9%	1%	-15%
AV	21%	-13%	-1%	-8%
EN	9%	-2%	5%	-14%
SC	22%	-2%	1%	-23%
MP	24%	-20%	1%	-6%
MI	34%	-6%	-2%	-27%
AG	19%	-18%	4%	-6%
FA	14%	-9%	4%	-10%
CM	25%	3%	-9%	-19%
TC	41%	-25%	-3%	-15%
OD	38%	-11%	-14%	-13%
QM	32%	-20%	-4%	-9%
WEIGHTED AVG	10%	-3%	2%	-9%

From the data in this Table 16, it appears that insufficient math, science, and engineering majors are available to meet the Army's need (see the bottom line of this table). In addition, Table 16 shows that the most severe shortages are in the CS/CSS branches. This distribution problem is the same one previously discussed as originating from the 80%/20% USMA accession process.

### The Current Situation

The recommendations of the 1991 Academic Discipline Mix Study Group were officially adopted by the DCSPER for use with the FY92 accession cycle. The formal adoption of the recommendations was a significant event for the

Army. Not only did the recommendations give a refined accession goal for "high technology" officers for FY92, it also created a dynamic system for updating and identifying the Army's needs for "high technology" officers in the future. This system is based on combining a "PROPONENT STATEMENT OF NEED" with an "OBJECTIVE STATEMENT OF NEED" to create the "ARMY STATEMENT OF NEED." As the two input statements of need change over time, the system allows for a new "ARMY STATEMENT OF NEED" to be generated quickly, logically, and consistently. The "ARMY STATEMENT OF NEED" has given the ROTC Cadet Command a sound basis for directing and influencing the scholarship program.

How has the Army been doing in the accession program since adopting the study group's recommendations? Table 17 is a summary of the officer accession data for FY92.

Table 17: 1992 Actual Accession Data.				
<u>SOURCE</u>	<u>GENERAL</u>	<u>TECH</u>	<u>PHY SCI</u>	<u>ENGR</u>
USMA	0	0	353	595
ROTC	1227	685	227	257
OCS	265	21	10	3
<b>TOTAL</b>	<b>1492</b>	<b>706</b>	<b>590</b>	<b>855</b>
<b>ACCESSED</b>	<b>40%</b>	<b>19%</b>	<b>16%</b>	<b>23%</b>
<b>DA GOAL</b>	<b>30%</b>	<b>25%</b>	<b>15%</b>	<b>30%</b>

The data in Table 17 shows that the Army needs to access more "engineers." Whereas the Army goal for "engineer" officers was 30% of all

accessions, only 23% of those commissioned were in the category.

Fortunately, the Army goal was met for "physical scientists." Overall, 39% of the FY92 accessions were "high technology" officers compared to the goal of 45%.

Table 17 discloses a very interesting statistic. While USMA graduates were only 26% of the total number of officer accessions in FY92, 70% of the "engineer" accessions and 60% of the "physical scientist" accessions came from West Point. In absolute numbers, USMA contributed TWICE AS MANY "high technology" officers as did all of the ROTC Cadet Command! While this statistic is impressive (especially for USMA's advocates!), how legitimate is this statistic?

This paper has already discussed how classifying USMA graduates specializing in an HPA field as "high technology" officers is exaggerated. While the 1989 definition of a "high technology" officer fattens the Army's and USMA's statistics of "engineer" and "physical scientist" accessions, it can be very misleading. In my opinion, it contributes to a significant understatement of the Army's REAL shortfall in "high technology" officers.

To make this point, I have redistributed USMA's FY92 officer accessions based upon each USMA officer's actual field of study.<sup>79</sup> The results are shown in Table 18. In other words, I have applied the ROTC criteria to the West Point graduates for 1992.

**Table 18: 1992 Accessions If ROTC Criteria  
Applied to USMA Accessions.**

<u>SOURCE</u>	<u>GENERAL</u>	<u>TECH</u>	<u>PHY SCI</u>	<u>ENGR</u>
USMA	342	72	120	414
ROTC	1227	685	227	257
OCS	265	21	10	3
<b>TOTAL</b>	<b>1834</b>	<b>778</b>	<b>357</b>	<b>674</b>
<b>%ACCESSED</b>	<b>50%</b>	<b>21%</b>	<b>10%</b>	<b>19%</b>
<b>%GOAL</b>	<b>30%</b>	<b>25%</b>	<b>15%</b>	<b>30%</b>
<b>SHORTFALL*</b>	<b>20%</b>	<b>-4%</b>	<b>-5%</b>	<b>-11%</b>

\*The shortfall indicates the difference between the %accessed and the %goal.

By applying the same criteria to ROTC and USMA, the shortfall in "high technology" officers becomes much worse. As shown in Table 18, 29% of the FY92 accessions were "high technology" officers compared to the goal of 45%. This is significantly different from the 6% shortfall in "high technology" officers indicated in Table 17.

Table 18 still shows that USMA provides the Army with the majority of its engineers; however, it establishes ROTC as the main source of physical scientists. It also reflects, in my opinion, a more realistic distribution of USMA graduates in the other two categories that are not "high technology." Not recognizing this in the current officer acquisition process can be misleading, and leads to a glaring overstatement of the Army's actual "high technology" officer accessions.

## **CONCLUSIONS, RECOMMENDATIONS, AND SUMMARY**

### **CONCLUSIONS**

This paper has examined the educational pipelines flowing into the Army's pool of technologically trained officers. Several conclusions have been reached:

1. There is an inadequate pool of scientifically prepared citizens to meet America's future technological challenges. As a result, it is incumbent on the Army to develop its own pool of officers who are technologically prepared to meet future leadership challenges.
2. At the United States Military Academy, there has been a substantial reduction in the number of math, science, and engineering courses in the core curriculum over the last thirty years. The portion of the core curriculum devoted to math, science, and engineering courses has been reduced to 15 courses. This is 37.5% of the overall graduation requirement of 40 total courses. In the author's opinion, classifying West Point graduates specializing in a humanities or public affairs field as "high technology" officers is exaggerated and misleading.
3. Since 1981, a system has evolved for establishing a minimum goal for "high technology" officers to meet future Army needs. The last refinement of that system was completed in 1991. It established a clear-cut methodology for developing the Army's need for "high technology" (engineer and physical scientist) officers in terms of four general categories. According to the Army's system, individual officer accessions are placed into one of the four categories

based upon the number of math, science, and engineering courses in that officer's undergraduate curriculum.

4. Currently, the overall Army need for "high technology" officers is 45% of the total officer accessions from USMA, ROTC, and OCS. In FY92, 39% of the actual officer accessions were officially classified as "high technology" officers. While the absolute value of this shortfall is only 6%, the shortage is much more severe in the combat support and combat service support branches. This is due primarily to the 80%/20% rule for USMA graduates.

5. Using the new definitions of "engineer" and "physical scientist," ALL USMA graduates are classified as "high technology" officers. In the author's opinion, this overstates the actual Army supply of "high technology" officers. The ROTC Cadet Command still uses the academic discipline (major) of its graduates as a basis for classification. If the ROTC Cadet Command criteria were used to classify USMA graduates, only 29% of the total FY92 actual officer accessions would be classified as "high technology" officers. While the official ("liberal") definition of "high technology" officer may look good statistically, the operational effect on the Army in future years could be serious.

6. The names given to the four categories used by the current system are not descriptive of the criteria used to assign the names. The assignment of the categories of "engineer" and "physical scientist" by the Army's officer acquisition system is considerably different from the customary use of these terms by people (military and civilian) who are not intimately acquainted with the Army's system. The author does not believe that the

Army's leadership understands that the use of the terms "engineer" and "physical scientist" is not necessarily related to the accepted use of the terms.

### **RECOMMENDATIONS**

The Army is limited in the actions it can take to effect the condition of America's civilian educational system. This is primarily the task of the civilian sector of the nation's leadership. Nevertheless, the Army must be cognizant of the general technological education received by Americans in its primary schools, secondary schools, and universities. If the condition of basic technological education continues to deteriorate, Army programs will have no foundation for its own pre-commissioning programs.

However, the Army has a duty to accurately articulate its need for "high technology" officers and to monitor the actual accessions to meet this need. Based upon this study's conclusions, the following recommendations are suggested for improving the Army's acquisition system for "high technology" officers

1. Continue to use the overall system recommended by the Academic Discipline Mix Study of 1991. The four categories used in that system (engineer, physical science, technical base, and generalist) are adequate and serve the needs of officer personnel managers. However, these four terms should be redefined (see the third recommendation below).

2. Continue to refine the Army's need for "high technology" officers. The ARMY STATEMENT OF NEED should be thoroughly analyzed to insure that it meets the Army's needs for the next several decades.

3. The methods used by ROTC and USMA in assigning accessions to the four categories must be consistent if the system is to work properly. Both



USMA and ROTC accessions should be classified based upon their degree title rather than percentage of the curriculum that is math, science, and engineering. The advantages of assigning the four categories by degree title are as follows:

a. The definitions of the four categories would agree with their common usage in civilian and military educational systems. Understanding of the system will be enhanced; misuse of the terms will be minimized.

b. The military's actual accession data would be more accurate and conservative. In the author's opinion, the present overstatement of the Army's actual accessions is not in the best interest of the nation.

4. Review the 80%/20% rule for USMA graduates after the effect of the implementation of the third recommendation is quantified. This study has concluded that the greatest shortage of "high technology" officers is in the combat support and combat service support branches. If USMA remains the major source of "high technology" officers, the technological needs of the Army dictate that more USMA graduates be allocated to these branches. However, upon implementation of the third recommendation, fewer USMA graduates will be categorized as "high technology" officers. The adjustment of the 80%/20% rule for USMA graduates may become unnecessary.

### **SUMMARY**

The nation's civilian and military leadership have stressed the need to maintain technological leadership to ensure military readiness and strength. This study investigated the overall status of technological education in the United States; the conclusions were foreboding and sobering.

Following this preliminary assessment, the study examined the Army's pre-commissioning programs. Specifically, it investigated whether the Army has an effective system for recruiting an adequate pool of officers prepared to assume leadership roles in an increasingly technological world. The study showed that the Army has implemented a sound system for developing the Army's need for "high technology" officers, and has closely monitored its officer acquisitions over the past several years. However, it concluded that the system is inconsistently applied by USMA and ROTC. This inconsistent application has resulted in the overstatement of the Army's actual supply of "high technology" officers. This study has made several recommendations for improvements to that system to make it more responsive to the needs of the Army and the nation.

## ENDNOTES

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<sup>3</sup>Chairman, Joint Chiefs of Staff, National Military Strategy of the United States (Washington, DC: U.S. Government Printing Office, 1992), 10.

<sup>4</sup>Jack R. Lohmann, "Myths, Facts, and the Future of U.S. Engineering and Science Education," Engineering Education, vol 81 (April 1991), 365.

<sup>5</sup>J.D. Miller, "Scientific Literacy," presented at the annual meeting of the American Association for the Advancement of Science, 17 January 1989, San Francisco, CA, as cited by Jack R. Lohmann, "Myths, Facts, and the Future of U.S. Engineering and Science Education," Engineering Education, vol 81 (April 1991), 365.

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<sup>7</sup>Ibid.

<sup>8</sup>"Education: Retooling the Schools," Wall Street Journal, 31 March 1989, p. R15.

<sup>9</sup>Ibid.

<sup>10</sup>Fred W. Beaufait, "An Engineering Curriculum for the Year 2000," Engineering Education 81, no. 4 (May/June 1991): 425.

<sup>11</sup>Ibid., 426.

<sup>12</sup>R. A. Ellis, "Engineering and Engineering Technology Degrees, 1990," Engineering Education 81, no. 1 (January/February 1991): 40.

<sup>13</sup>Ibid.

<sup>14</sup>Lohmann, 366.

<sup>15</sup>Ellis, 41.

<sup>16</sup>Bonney H. Sheahan and John A. White, "Quo Vadis, Undergraduate Engineering Education?," Engineering Education 80, no. 8 (December, 1990): 1020.

<sup>17</sup>Lohmann, 368.

<sup>18</sup>W.I. Weiss, Report of the 1985-86 National Survey of Science and Mathematics Education (Research Triangle Institute, NC, 1987) as cited by Jack R. Lohmann, "Myths, Facts, and the Future of U.S. Engineering and Science Education," Engineering Education, vol 81 (April 1991), 368.

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<sup>20</sup>Weiss.

<sup>21</sup>Sheahan and White, 1020.

<sup>22</sup>Weiss.

<sup>23</sup>Lohmann, 369.

<sup>24</sup>Weiss.

<sup>25</sup>Ibid.

<sup>26</sup>Ibid.

<sup>27</sup>L.S. Williams, "Mathematics and Science Education: A National Strategy," The Bridge 20, no. 2 (Fall 1990), pp. 10-14 cited in Jack R. Lohmann, "Myths, Facts, and the Future of U.S. Engineering and Science Education," Engineering Education, vol 81 (April 1991), 367.

<sup>28</sup>Lohmann, 367.

<sup>29</sup>A Nation At Risk, report of the National Commission on Excellence in Education (Washington, D.C.: U.S. Government Printing Office, April 1983), 1.

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<sup>32</sup>Department of Defense, IV-7.

<sup>33</sup>John P. Lovell, Neither Athens Nor Sparta? (Bloomington: Indiana University Press, 1979), 23.

<sup>34</sup>Ibid., 24.

<sup>35</sup>Gerald E. Galloway, "Academic Limits," Assembly, XLVIII, no. 10 (1991), 34.

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<sup>39</sup>Hillman Dickinson, Jack V. Mackmull, and Jack N. Merritt, "West Point Study Group," Assembly, XXXVI, no. 3 (1977), 7.

<sup>40</sup>*Ibid.*, 8.

<sup>41</sup>Frederick A. Smith, Jr., "Revised Academic Curriculum," Assembly, XXXVII, no. 2 (1978) 3.

<sup>42</sup>United States Military Academy, Annual Report of the Superintendent: 1980, (West Point, NY: U.S. Department of the Army, July 1980), 9.

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<sup>46</sup>Office of the Superintendent Letter, "Revised Academic Program," (West Point, NY: U.S. Department of the Army, 4 January 1978), 4.

<sup>47</sup>Roy K. Flint, "Academic Limits," Assembly (December 1989), 35.

<sup>48</sup>*Ibid.*, 34.

<sup>49</sup>United States Military Academy, Annual Report of the Superintendent: 1983 through Annual Report of the Superintendent: 1989, (West Point, NY: U.S. Department of the Army, 1983 through 1989).

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<sup>57</sup>Study Group for the Review of Education and Training for Officers, C-4.

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<sup>61</sup>Study Group for the Chief of Staff of the Army, 4-1-22.

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<sup>63</sup>Ibid., 4-1-23.

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<sup>76</sup>MG James W. Van Loben Sels, "High Technology Requirements for Lieutenants Accessed by the Basic Branches," memorandum for the Deputy Chief of Staff for Personnel (Fort Monroe, Virginia: TRADOC, 25 July 1991), Tab A.

<sup>77</sup>Ibid., Tab F.

<sup>78</sup>Ibid., Tab A.

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